

CHEMISTRY (CHEM)

100 Level Courses

CHEM 101: *Introduction to Modern Chemistry*. 3 credits.

Physical and chemical discoveries and properties of matter presented along with their application and impact on way of life. Topics include atomic and molecular structure, nuclear chemistry, and chemistry in Earth and atmosphere. Note: does not fulfill the requirement for a laboratory course in chemistry. Not for chemistry majors. No credit given for both CHEM 101 and CHEM 103 or for both CHEM 101 and CHEM 211-212. No previous knowledge of chemistry required. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science Overview (<http://catalog.gmu.edu/mason-core/>)

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 102: *Chemistry for Changing Times*. 3 credits.

Modern course to explore and discover chemistry in the 21st century with an emphasis on current societal concerns. Examines carbon-containing compounds such as polymers, biomolecules, drugs, and fuels, which play a central role in medicine, manufacturing, green energy, and forensic science. Topics include examples from organic chemistry, conformational analysis, stereochemistry, genetics, and protein-protein interactions. (CHEM 102 does not require concomitant registration in a 104 lab section.) Notes: Not open to students majoring in Chemistry, not intended for science majors. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science Overview (<http://catalog.gmu.edu/mason-core/>)

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 103: *Chemical Science in a Modern Society*. 4 credits.

Terminal course in chemistry for nonscience and nursing majors. Principles and application of chemistry. Notes: CHEM 103 and CHEM 101 are taught simultaneously in the same room. CHEM 101 is for those students who are not required to complete the lab component of CHEM 103. Not open to students majoring in chemistry. Credit will not be given for both this course and CHEM 211, 212. Topics are those described for CHEM 101 and 102 but with lab to enhance scientific experience. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 104: *Chemistry for Changing Times*. 4 credits.

Modern course in to explore and discover chemistry in the 21st century with an emphasis on current societal concerns. Examines carbon-containing compounds such as, polymers, biomolecules, drugs, and fuels, which play a central role in medicine, manufacturing, green energy, and forensic science. Topics include examples from organic chemistry, conformational analysis, stereochemistry, genetics, and protein-protein interactions. (CHEM 104 requires concomitant registration in a 104 lab section.) Notes: Not open to students majoring in Chemistry, not intended for science majors or credit for 211 and 213. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 105: *Introductory Chemistry Laboratory I*. 1 credit.

Introductory laboratory course to demonstrate principles and application of chemistry. Notes: Not open to students majoring in chemistry. Credit will not be given for both this course and CHEM 211, 212. Students will enroll in CHEM 105 by Individualized Section and attend one of the CHEM 103 lab sections. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Prerequisite: CHEM 101.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 106: *Introductory Chemistry Laboratory II*. 1 credit.

1-credit laboratory course for non-science majors. Laboratory experience to demonstrate principles and application of chemistry. Notes: Not open to students majoring in chemistry. Credit will not be given for both this course and CHEM 211, 212. Students will enroll in CHEM 106 by Individualized Section and attend one of the CHEM 104 lab sections. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Prerequisite: CHEM 102.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 155: *Introduction to Environmental Chemistry I*. 4 credits.

Basic chemical principles of Earth's water, air, and soil systems; presented in the context of understanding environmental issues. Includes

Saturday morning field trips to sites of past and present environmental contamination, alternating with Saturday morning laboratory activities. Notes: Credit will not be given for this course and CHEM 103, 104. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science with Lab, Encore: Sustainability (<http://catalog.gmu.edu/mason-core/>)

Specialized Designation: Green Leaf Related Course

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 156: *Introduction to Environmental Chemistry II.* 4 credits. Basic chemical principles of Earth's water, air, and soil systems; presented in the context of understanding environmental issues. Includes Saturday morning field trips to sites of past and present environmental contamination, alternating with Saturday morning laboratory activities. Notes: Credit will not be given for this course and CHEM 103, 104. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science with Lab, Encore: Sustainability (<http://catalog.gmu.edu/mason-core/>)

Specialized Designation: Green Leaf Related Course

Recommended Prerequisite: CHEM 155 or permission of instructor.

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

200 Level Courses

CHEM 211: *General Chemistry I.* 3 credits. Fundamental principles of atomic and molecular structure; chemical bonding; basic concepts of chemical reactions and thermochemistry; properties of gases, liquids, and solids. Notes: CHEM 211 must be taken concurrently with CHEM 213 on the first attempt. Credit will not be given for this course and CHEM 103, 104. Students majoring in science, engineering, or mathematics should choose this course sequence. CHEM 211 is a prerequisite to CHEM 212. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Registration Restrictions:

Required Prerequisites: CHEM 213^{*C}, U213^{*}, 213T^{*} or 213^{XS}.

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 212: *General Chemistry II.* 3 credits.

Fundamentals of colligative properties, reaction rates and equilibrium. Topics Include kinetics, properties of solutions, ionic equilibrium, chemical thermodynamics, electrochemistry, and nuclear chemistry. Notes: CHEM 212 must be taken concurrently with CHEM 214 on the first attempt. Credit will not be given for this course and CHEM 103, 104. Students majoring in science, engineering, or mathematics should choose this course sequence. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts. Equivalent to CHEM 202.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Registration Restrictions:

Required Prerequisites: (CHEM 211^C, 211T, U211 or 211^{XS}) and (CHEM 213^C, 213T, U213 or 213^{XS}) and (CHEM 214^{*C}, 214T^{*}, U214^{*} or 214^{XS}).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 213: *General Chemistry Laboratory I.* 1 credit. General Chemistry laboratory course for students majoring in science, engineering, or mathematics. Laboratory experience will demonstrate general chemistry principles and applications. Notes: Students majoring in science, engineering, or mathematics should choose this course sequence. Credit will not be given for this course and CHEM 103. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Registration Restrictions:

Required Prerequisites: CHEM 211^{*C}, U211^{*}, 211T^{*} or 211^{XS}.

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 214: *General Chemistry Laboratory II.* 1 credit. General Chemistry laboratory course for students majoring in science, engineering, or mathematics. Laboratory experience will demonstrate general chemistry principles and applications. Notes: Credit will not be given for this course and CHEM 103, CHEM 104. Students majoring in science, engineering, or mathematics should choose this course sequence. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts. Equivalent to CHEM 204.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Registration Restrictions:

Required Prerequisites: (CHEM 212^{*C}, U212^{*}, 212T^{*} or 212^{XS}) and (CHEM 211^C, 211T, U211 or 211^{XS}) and (CHEM 213^C, 213T, U213 or 213^{XS}).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 271: General Chemistry for Engineers Lecture. 3 credits.

Fundamental principles of chemical structure and reactivity including atomic and molecular structure; chemical bonding; structures of ionic, covalent, and metallic lattices; oxidation reduction; electrochemistry and chemistry of metals; and introduction to organic chemistry and polymers. Notes: CHEM 271 must be taken concurrently with CHEM 272 on the first attempt. Enrollment restricted to students intending to major in engineering. Students who need two semesters of chemistry should enroll in CHEM 211/CHEM 213 and CHEM 212/CHEM 214. Credit will not be given for this course and CHEM 211/CHEM 213. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Mason Core: Natural Science with Lab, Natural Science Overview (<http://catalog.gmu.edu/mason-core/>)

Registration Restrictions:

Required Prerequisites: CHEM 272^{*C} or 272^{XS}.

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students in the Engineering Computing college.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 272: General Chemistry for Engineers Lab. 1 credit.

Lab course to accompany CHEM 271 Lecture. General Chemistry laboratory course for students majoring in engineering. Laboratory experience will demonstrate general chemistry principles and applications. Corequisite CHEM 271. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Mason Core: Natural Science with Lab (<http://catalog.gmu.edu/mason-core/>)

Registration Restrictions:

Required Prerequisites: CHEM 271^{*C} or 271^{XS}.

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

300 Level Courses

CHEM 310: Survey of Organic Chemistry. 3 credits.

A one-semester survey of the chemistry of organic compounds with emphasis on structure, properties, stereochemistry, nomenclature, synthesis, and reactions of the major functional group families. Applications and compounds of importance to biology and biochemistry stressed. Credit will not be given for this course and CHEM 313; credit will not be given for this course and CHEM 314. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 271^C or 271^{XS}) and (CHEM 272^C or 272^{XS}) or ((CHEM 211^C or 211^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 212^C or 212^{XS}) and (CHEM 214^C or 214^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 313: Organic Chemistry I. 3 credits.

Theoretical, synthetic, industrial, and biological aspects of the chemistry of carbon compounds. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Corequisite: CHEM 315.

Registration Restrictions:

Required Prerequisites: ((CHEM 212^C, U212 or 212^{XS}) and (CHEM 211^C or 211^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 214^C or 214^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 314: Organic Chemistry II. 3 credits.

Theoretical, synthetic, industrial, and biological aspects of the chemistry of carbon compounds. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Corequisite: CHEM 318.

Registration Restrictions:

Required Prerequisites: ((CHEM 313^C, L313 or 313^{XS}) and (CHEM 211^C or 211^{XS}) and (CHEM 212^C or 212^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 214^C or 214^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 315: Organic Chemistry Lab I. 2 credits.

Lab techniques and reactions arranged to accompany CHEM 313. Notes: One-hour recitation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 313^C, 313^{XS} or L313^{*}) and (CHEM 211^C or 211^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 212^C or 212^{XS}) and (CHEM 214^C or 214^{XS})).

^{*} May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 318: Organic Chemistry Lab II. 2 credits.

Continuation of CHEM 315, arranged to accompany CHEM 314. Notes: One-hour recitation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Recommended Corequisite: CHEM 314

Registration Restrictions:

Required Prerequisites: ((CHEM 211^C, 211^{XS} or U211) and (CHEM 213^C, 213^{XS} or U213) and (CHEM 212^C, 212^{XS} or U212) and (CHEM 214^C, 214^{XS} or U214) and (CHEM 313^C, 313^{XS} or L313) and (CHEM 314^{*C}, 314^{XS} or L314) and (CHEM 315^C, 315^{XS} or L315)).

^{*} May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 321: Quantitative Chemical Analysis. 4 credits.

Principles of chemical analysis emphasizing ionic equilibria. Lab consists of gravimetric, volumetric, and instrumental methods illustrating principal types of quantitative determinations. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 212^C or 212^{XS}) and (MATH 113^C or 113^{XS}) and (CHEM 211^C or 211^{XS}) and (MATH 114^{*C} or 114^{XS}).

^{*} May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 322: Quantitative Chemical Analysis Lecture. 3 credits.

Lecture portion of CHEM 321. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 211^C or 211^{XS}) and (CHEM 212^C or 212^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 214^C or 214^{XS}) and (MATH 113^C or 113^{XS}) and (MATH 114^C or 114^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 323: Quantitative Chemical Analysis Laboratory. 1 credit.

Laboratory component of CHEM 321. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 322^C or 322^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 331: Physical Chemistry I. 3 credits.

Yearlong survey covering topics including thermodynamics, equilibria, kinetics, solution properties, elementary quantum theory, electrochemistry, atomic and molecular structure, and nuclear chemistry. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 212^C or 212^{XS}) and (CHEM 211^C or 211^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 214^C or 214^{XS}) and (MATH 114^C, 114^{XS}, 116^C or 116^{XS}) and (PHYS 243^{*C}, 243^{XS}, 160^{*C} or 160^{XS}).

^{*} May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 332: Physical Chemistry II. 3 credits.

Yearlong survey covering topics including thermodynamics, equilibria, kinetics, solution properties, elementary quantum theory, electrochemistry, atomic and molecular structure, and nuclear chemistry. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((MATH 114^C or 114^{XS}) and (CHEM 331^C or 331^{XS})) and (PHYS 243^C, 243^{XS}, 160^C or 160^{XS}) and (PHYS 244^{*C}, 244^{XS}, 260^{XS} or 260^{*C}).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 336: Physical Chemistry Lab I. 2 credits.

Quantitative experimental study of physicochemical principles.

CHEM 336 and 337 constitute an introduction to the practice and theory of experimental physical chemistry. Notes: One-hour recitation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Specialized Designation: Writing Intensive in Major

Registration Restrictions:

Required Prerequisites: ((CHEM 212^C or 212^{XS}) and (CHEM 321^C or 321^{XS}) and (CHEM 331^{*C} or 331^{XS}) and (PHYS 243^{*C}, 243^{XS}, 160^{*C} or 160^{XS}) and (MATH 114^C, 114^{XS}, 116^C or 116^{XS})).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 337: Physical Chemistry Lab II. 2 credits.

Continuation of CHEM 336. Notes: One-hour recitation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 331^C, 331^{XS} or L331) and (CHEM 332^{*C}, 332^{XS} or L332^{*}) and (CHEM 336^C, 336^{XS} or L336)).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 355: Undergraduate Research. 1-3 credits.

Original research project. May involve lab study, computer modeling and analysis, or other original research as appropriate. Research formulated and completed under instructor's guidance. Culminates in a written and oral final report. May be repeated for a total of 6 credits. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree for a maximum 6 credits.

Registration Restrictions:

Required Prerequisites: (CHEM 313^C or 313^{XS}) and (CHEM 315^C or 315^{XS}) and (MATH 113^C or 113^{XS}) and (PHYS 243^C or 243^{XS}) and (PHYS 244^C or 244^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Junior, Sophomore, Senior Plus or Senior.

Enrollment is limited to students with a major, minor, or concentration in Chemistry.

Schedule Type: Research

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

400 Level Courses

CHEM 413: Synthetic and Mechanistic Organic Chemistry. 3 credits.

General review of synthetic pathways and applications to new topics, emphasizing fused ring aromatics, heterocyclics, natural products, and biologically active compounds. Includes relationship of applied organic chemistry to consumer products, including drugs and agricultural chemicals. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 314^C, L314 or 314^{XS}) and (CHEM 318^C, L318 or 318^{XS}) and (CHEM 331^C or 331^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 422: Instrumental Methods of Chemical Analysis. 3 credits.

Introduces theories of analysis by instrumental methods. Basic electronics applied to chemical measurements. Topics include introduction to theory of spectroscopy including ultraviolet, visible, and infrared, and electrochemical methods of analysis; theory of Fourier transform techniques such as FT-IR and FT-NMR; and theory of advanced pulse techniques. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 321^C or 321^{XS}) and (CHEM 332^C or 332^{XS}) and (CHEM 336^C or 336^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 423: Instrumental Methods of Chemical Analysis Laboratory. 2 credits.

Laboratory-based introduction to quantitative analysis of organic and inorganic substances by using modern analytical instrumentation.

Laboratory highlights practice of atomic and molecular spectroscopy, spectrophotometry, chromatography, voltammetry, and potentiometry in relation to chemical experimentation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 422^C or 422^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 424: Principles of Chemical Separation. 3 credits.

Theories and models of separation with applications to analyses of a wide range of chemical, biological, and environmental samples. Topics include high-resolution gas and high-performance liquid chromatography. Emphasizes theory of reverse phase, normal phase, ion exchange, size exclusion, and affinity based separations. Also presents instrumentation such as detectors, pumps, columns, and data acquisition. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Prerequisite: CHEM 332 or CHEM 422 or Permission of instructor

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 425: Electroanalytical Chemistry. 3 credits.

Review of basic electrochemistry. Emphasizes analysis and research for applications of modern electrochemical techniques such as chronoamperometry; cyclic, stripping, and AC voltammetry; pulse polarography; coulometry; electrochemical sensors; and instrumentation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Prerequisite: CHEM 332 or CHEM 422 or permission of instructor.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 427: Aquatic Environmental Chemistry. 3 credits.

Thermodynamic and kinetic processes regulating the chemistry of surface and groundwater in natural and polluted environments with particular emphasis in explaining the aqueous concentrations of chemical species and controlling geochemical factors in the hydrosphere. Structure, sources and transformations of organic matter in the aquatic environment and interactions with aqueous solutes will be covered as related to contemporary issues in water quality. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 321^C or 321^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 438: Atmospheric Chemistry. 3 credits.

The fundamental chemical processes of the Earth's atmosphere including chemical cycles, thermodynamics, reaction kinetics, photochemistry, radiative balance, ozone chemistry and environmental issues, including air pollution, acid rain and global change. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts. Equivalent to CLIM 438.

Registration Restrictions:

Required Prerequisites: (CHEM 332^C or 332^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 439: RS: Atmospheric Chemistry II: Air Analysis Techniques. 3 credits.

The theory, design and implementation of air sampling and analysis techniques for investigating GMU and regional air quality. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Specialized Designation: Research/Scholarship Intensive

Recommended Prerequisite: CHEM 438 or permission of instructor.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 441: Properties and Bonding of Inorganic Compounds. 3 credits.

Interpretation of physical and chemical properties of inorganic compounds in terms of currently used bonding concepts. Topics include molecular symmetry and applications of symmetry, structure and bonding in ionic solids; reactions and characterizations of solids; electronic and magnetic properties and applications of solids. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 332^C or 332^{XS}) and (CHEM 336^C or 336^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 445: Inorganic Preparations and Techniques. 2 credits.

Application of techniques of inorganic chemistry to preparation, purification, and spectroscopic characterization of selected substances. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Specialized Designation: Mason Impact.

Registration Restrictions:

Required Prerequisites: (CHEM 441^C or 441^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 446: Bioinorganic Chemistry. 3 credits.

Application of inorganic coordination chemistry and physical methods in study of structure and function of metal ion sites in biomolecules. Properties of transition metal ions, ligand field theory. Topics include iron cytochromes, zinc and copper enzymes, cobalamins, iron sulfur proteins, oxygen transport, iron storage, electron transfer, inorganic model compounds, metals in medicine, and toxicity of inorganic species. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 463^C, 463^{XS}, BIOL 483^C or 483^{XS}) and (CHEM 331^C or 331^{XS}) and (CHEM 336^C or 336^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 451: Special Projects in Chemistry. 1-3 credits.

Introduction to chemical research or development. Includes literature search, conferences, and lab. Notes: Written and oral technical reports required. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 314^C or 314^{XS}) and (CHEM 318^C or 318^{XS}) and (CHEM 321^C or 321^{XS}) and (CHEM 331^C or 331^{XS}) and (CHEM 336^C or 336^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major, minor, or concentration in Chemistry.

Schedule Type: Research

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 452: Special Projects in Chemistry. 1-3 credits.

Introduction to chemical research or development. Includes literature search, conferences, and lab. Notes: Written and oral technical reports required. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 451^C or 451^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major, minor, or concentration in Chemistry.

Schedule Type: Research

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 455: Honors Research in Chemistry. 3 credits.

Introduction to research on current problem in chemical sciences under supervision of faculty advisor. Includes literature search, laboratory or theoretical work, conferences with faculty advisor, attendance at regularly scheduled seminars, and oral and written presentations. Notes: Credit will not be given for both these courses and CHEM 451, 452. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 313^C or 313^{XS}) and (CHEM 314^C or 314^{XS}) and (CHEM 315^C or 315^{XS}) and (CHEM 318^C or 318^{XS}) and (CHEM 331^C or 331^{XS}) and (CHEM 336^C or 336^{XS}) and (CHEM 490^{*C} or 490^{XS}).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major in Chemistry.

Enrollment limited to students with the Honors Coll Schlrshp Confirmd, Honors College. or Honors in the Major. attributes.

Schedule Type: Research

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 456: Honors Research in Chemistry. 3 credits.

Introduction to research on current problem in chemical sciences under supervision of faculty advisor. Includes literature search, laboratory or theoretical work, conferences with faculty advisor, attendance at regularly scheduled seminars, and oral and written presentations. Notes: Credit will not be given for both these courses and CHEM 451, 452. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to two attempts.

Registration Restrictions:

Required Prerequisites: CHEM 455^C and (CHEM 490^{*C} or 490^{XS}).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major in Chemistry.

Enrollment limited to students with the Honors Coll Schlrshp Confirmd, Honors College. or Honors in the Major. attributes.

Schedule Type: Research

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 458: *Chemical Oceanography*. 3 credits.

The world's oceans, including a variety of closed basins and estuaries, comprise a complex and dynamic system of chemical processes that interact with biological, geological, physical, and atmospheric processes to play a significant role in defining the earth's fragile environment. This course will present an overview of the origin, occurrence, and distribution of the chemical components in sea water and an introduction to the basic principles of the chemical processes taking place in the marine environment. Designated a Green Leaf Course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts. Equivalent to GEOL 458.

Specialized Designation: Green Leaf Related Course

Registration Restrictions:

Required Prerequisites: ((CHEM 211^C or 211^{XS}) and (CHEM 212^C or 212^{XS}) and (CHEM 321^C, 321^{XS}, GEOL 309^C or 309^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 460: *Chemistry in the Kitchen*. 3 credits.

One semester synthesis course exploring the chemistry observed and experienced in household kitchens. As chemistry is the study of matter and its changes, this course explores the chemistry of the food we eat and cook on a molecular level. Students will participate in a creative and scholarly project, practice scientific communication skills, and learn to apply a chemical perspective to real world situations. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Prerequisite: CHEM 211/213 and CHEM 212/214 (or CHEM 271/272), CHEM 313/315 (or CHEM 310), and CHEM 463, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Junior or Senior.

Schedule Type: Laboratory, Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 463: *General Biochemistry I*. 4 credits.

Brief introduction to biochemistry, followed by in-depth look at amino acids and proteins, 3-D structure, folding and dynamics, their specialized function, and primary metabolism. Emphasizes enzymes and their chemical mechanisms, and metabolism. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts. Equivalent to BIOL 483.

Registration Restrictions:

Required Prerequisites: (CHEM 313^C, 313^{XS} or L313) and (BIOL 213^C or 213^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 464: *General Biochemistry II*. 3 credits.

Continuation of general biochemistry, focusing on secondary metabolism, cell signaling, and processes of replication, transcription, and translation. Emphasizes important biochemistry research topics; much material drawn from current biochemical literature. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 463^C or 463^{XS}) or ((BIOL 483^C or 483^{XS}) and (CHEM 314^C, 314^{XS} or L314)).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 465: *Biochemistry Lab*. 2 credits.

Introduction to modern biochemical experimental methods of studying chemical and physical properties of biological molecules. Includes separation, identification, and characterization of biomolecules. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Specialized Designation: Writing Intensive in Major

Recommended Prerequisite: Grade of C or better in CHEM 315 and CHEM 463.

Recommended Corequisite: CHEM 463.

Registration Restrictions:

Required Prerequisites: (CHEM 463^{*C}, 463^{XS}, BIOL 483^C or 483^{XS}) and (CHEM 315^C, 315^{XS} or L315).

* May be taken concurrently.

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 467: *The Chemistry of Enzyme-Catalyzed Reactions*. 3 credits. Examples of enzyme mechanisms demonstrate how chemical principles are employed by living organisms. Specific enzyme mechanisms used to illustrate principles from organic, inorganic, and physical chemistry. Discusses techniques to monitor enzyme reactions. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 463^C or 463^{XS}) and (CHEM 464^C or 464^{XS}) and (CHEM 314^C or 314^{XS}) and (CHEM 331^C or 331^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 468: *Bioorganic Chemistry*. 3 credits.

Basic understanding of chemical nature of biomolecules and biomacromolecules. Introduces biomolecules such as amino acids, proteins, carbohydrates, and lipids. Lectures focus on biophysical properties and synthesis, using practical examples and visual aids. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 463^C, 463^{XS}, BIOL 483^C or 483^{XS}) and (CHEM 314^C or 314^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 470: *Laboratory Instructional Methods for Chemistry*. 3 credits. Lecture and laboratory experience teaching chemistry in laboratory. Students work closely with faculty members and are responsible for all aspects of teaching undergraduate laboratory techniques. Students also learn techniques for acquisition and storage of chemicals and laboratory apparatus, safety, disposal of chemical waste, and literature of chemical education. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Recommended Prerequisite: CHEM 314.

Schedule Type: Laboratory

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 471: *Solid State Chemistry*. 3 credits.

Focuses on the design and synthesis, structure and bonding of solid state compounds, physical properties and characterization of solids. Topics of current interest will also be included. Offered by

Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: (CHEM 441^C or 441^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 472: *Modern Polymer Chemistry*. 3 credits.

Synthetic and analytical chemistry of synthetic macromolecules. Topics include polymer solutions, molecular weight determination, spectroscopy, thermal analysis, x-ray crystallinity, polymerization types, and commercial and electroactive polymers. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 313^C or 313^{XS}) and (CHEM 314^C or 314^{XS}) and (CHEM 321^C or 321^{XS}) and (CHEM 331^C or 331^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 480: *Fundamentals of Nanoscience and Nanomaterials*. 3 credits.

This course will i) start with physical chemistry and surface science to elucidate the fundamental concepts and unique properties of solid materials emerging at the nanoscale; ii) introduce both "top-down" and "bottom-up" approaches to the fabrication of nanostructures and nanomaterials; iii) discuss advanced tools for characterizing the physical and chemical properties of nanomaterials; iv) review recent developments of nanomaterials for applications in catalysis, electronics, optoelectronics, energy, and nanomedicine; and v) discuss the environmental, health and safety (EHS) issues of nanomaterials for understanding the societal impact of nanotechnology. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). Limited to three attempts.

Registration Restrictions:

Required Prerequisites: ((CHEM 331^C or 331^{XS}) and (CHEM 332^C or 332^{XS}) and (MATH 113^C or 113^{XS}) and (MATH 114^C or 114^{XS})).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Schedule Type: Lecture

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 490: *Undergraduate Seminar*. 1 credit.

Selected topics from recent chemical theory and applications, generally consisting of research presentations by invited faculty from other institutions. Attendance is required at 80% of the seminars and students must write up a one-page summary of each talk attended. This course

will also be used to teach students how to give effective presentations. May be repeated for a total of 2 credits. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree for a maximum 2 credits.

Registration Restrictions:

Required Prerequisites: (CHEM 331^C, 331^{XS}, 336^C or 336^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Senior Plus or Senior.

Enrollment is limited to students with a major, minor, or concentration in Chemistry.

Schedule Type: Seminar

Grading:

This course is graded on the Undergraduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

500 Level Courses

CHEM 500: *Selected Topics in Modern Chemistry*. 3 credits.

Topics of interest in analytical, biological, environmental, geological, geochemical, inorganic, organic, and physical chemistry. Notes: Credit not allowed toward major in chemistry. Credit not allowed toward minor in chemistry. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Specialized Designation: Topic Varies

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 513: *Synthetic and Mechanistic Organic Chemistry*. 3 credits.

General review of synthetic pathways and applications to new topics, emphasizing fused ring aromatics, heterocyclics, natural products, and biologically active compounds. Includes relationship of applied organic chemistry to consumer products, including drugs and agricultural chemicals. Organic core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: Grade of C or better in CHEM 314, CHEM 318 and CHEM 331.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 529: *Instrumental Techniques of Analysis*. 2 credits.

Principles and operation of modern instrumentation, emphasizing applications to analysis of chemical, biological, and environmental samples. Methods include combined capillary column gas chromatography and mass spectrometry, high-performance liquid chromatography, optical methods, surface analysis methods, magnetic resonance spectroscopy, atomic emission and absorption spectrometry, and electroanalytical methods. With approval of research committee, students choose methods studied. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the term.

Specialized Designation: Topic Varies

Recommended Prerequisite: CHEM 321 and 422 or 521 or permission of department.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Independent Study

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 531: *Elements of Physical Chemistry*. 3 credits.

The course offers an intensive overview of the concepts, techniques, and models of physical chemistry as they apply to many branches of chemistry and allied sciences. The emphasis is for the students to develop practical skill in applying the concepts of thermodynamics, kinetics, and quantum mechanics to chemical systems at both the macroscopic and the atomic/molecular level. This course will use spreadsheet models to investigate chemical and physical systems. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 211, 212; CHEM 313, 314; PHYS 243, 245 (college physics), MATH 113, or Permission of Instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 560: Environmental Biotechnology. 3 credits.

Biotechnology plays a central role in many environmental fields, such as wastewater treatment, bioremediation, pathogen control, and biofuel production. The objective of the course is to provide environmental scientists with advanced chemical and biochemical concepts necessary for understanding environmental processes and control systems. The course integrates chemical, biological, and biochemical principles for building a quantitative framework applicable to various environmental biotechnologies. The course begins with a revision of the fundamentals of microbiology, biochemistry, and molecular biology. Quantitative concepts of biochemical and microbial kinetics, metabolic pathways, and bioenergetics are then covered, with special emphasis on environmental processes. These principles are applied to different environmental biotechnologies, including water and wastewater treatment, bioremediation, environmental genomics, biofuel production, and biosensors. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 446 Bioinorganic Chemistry, BIOL 213 Cell Structure & Function, or equivalent courses

Registration Restrictions:

Required Prerequisites: (CHEM 211^C or 211^{XS}) and (CHEM 213^C or 213^{XS}) and (CHEM 212^C or 212^{XS}) and (CHEM 214^C or 214^{XS}).

^C Requires minimum grade of C.

^{XS} Requires minimum grade of XS.

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 563: General Biochemistry I. 4 credits.

Brief introduction to biochemistry, followed by an in-depth look at amino acids and proteins, 3-D structure, folding and dynamics, their specialized function and primary metabolism. Emphasizes enzymes and their chemical mechanisms and metabolism. Students will be assigned papers from the primary literature and be required to answer questions from these papers on exams. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 313, BIOL 213.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 564: General Biochemistry II. 3 credits.

Previous course in biology recommended but not required. Important biological compounds, including proteins, carbohydrates, lipids, and nucleic acids, and their interrelations. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 563 or equivalent.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 567: The Chemistry of Enzyme-Catalyzed Reactions. 3 credits.

Examples of enzyme mechanisms demonstrate how chemical principles are employed by living organisms. Specific enzyme mechanisms used to illustrate principles from organic, inorganic, and physical chemistry. Discusses techniques to monitor enzyme reactions. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 313 and 463 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 568: Bioorganic Chemistry. 3 credits.

Basic understanding of chemical nature of biomolecules and biomacromolecules. Introduces biomolecules such as amino acids, proteins, carbohydrates, and lipids. Lectures focus on biophysical properties and synthesis, using practical examples and visual aids. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 314 and 463, or equivalent, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 579: *Special Topics*. 1-6 credits.

Current topics in chemistry, depending on instructor's specialty. Notes: May be repeated with different topics, with department approval. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the term.

Specialized Designation: Topic Varies

Recommended Prerequisite: CHEM 313 and 314, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lec/Sem #1, Lec/Sem #2, Lec/Sem #3, Lec/Sem #4, Lec/Sem #5, Lec/Sem #6, Lec/Sem #7, Lec/Sem #8, Lec/Sem #9, Lecture, Sem/Lec #10, Sem/Lec #11, Sem/Lec #12, Sem/Lec #13, Sem/Lec #14, Sem/Lec #15, Sem/Lec #16, Sem/Lec #17, Sem/Lec #18

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

600 Level Courses

CHEM 613: *Modern Polymer Chemistry*. 3 credits.

Synthetic and analytical chemistry of synthetic macromolecules. Topics include polymer solutions, molecular weight determination, spectroscopy, thermal analysis, x-ray crystallinity, polymerization types, and commercial and electroactive polymers. Organic core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 614: *Physical Organic Chemistry*. 3 credits.

Principles underlying molecular structure, reactivity, and reaction mechanisms. Topics include valence-bond and molecular-orbital theory, electronic interpretation of organic reactions, stereochemistry, conformational analysis, kinetics and thermodynamics of organic reactions, and photochemistry. Organic core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 314 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 620: *Modern Instrumentation*. 3 credits.

Methods of sensing and measurement of radiation, particles, pressure, concentrations of specific elements and compounds. Topics include basic operational amplifier circuits for analog signals, digitizing devices and computerized data collection, noise and noise-reduction methods, and specialized instrumentation systems for various areas of chemistry and physics. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 332 or CHEM 422 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 624: *Principles of Chemical Separation*. 3 credits.

Theories and models of separation with applications to analyses of a wide range of chemical, biological, and environmental samples. Topics include high-resolution gas and high-performance liquid chromatography. Emphasizes theory of reverse phase, normal phase, ion exchange, size exclusion, and affinity based separations. Also presents instrumentation such as detectors, pumps, and columns, and data acquisition. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 332 or CHEM 422 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 625: *Electroanalytical Chemistry*. 3 credits.

Review of basic electrochemistry. Emphasizes analysis and research for applications of modern electrochemical techniques such as chronoamperometry; cyclic, stripping, and AC voltammetry; pulse polarography; coulometry; electrochemical sensors; and instrumentation. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 332 or CHEM 422 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 627: *Aquatic Environmental Chemistry*. 3 credits.

Thermodynamic and kinetic processes regulating the chemistry of surface and groundwater in natural and polluted environments with particular emphasis in explaining the aqueous concentrations of chemical species and controlling geochemical factors in the hydrosphere. Structure, sources and transformations of organic matter in the aquatic environment and interactions with aqueous solutes will be covered as related to contemporary issues in water quality. Students will be assigned papers from the primary literature and be required to answer questions from these papers on exams. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 321 or GEOL 302 or equivalent courses or permission of the instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 633: *Chemical Thermodynamics and Kinetics*. 3 credits.

Advanced study covering application of kinetics to the elucidation of reaction mechanisms and application of statistical thermodynamics to theory of elementary reaction rates. Physical core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit. Equivalent to CSI 711.

Recommended Prerequisite: CHEM 331 and 332.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 641: *Solid State Chemistry*. 3 credits.

Focuses on the design and synthesis, structure and bonding of solid state compounds; physical properties and characterization of solids. Topics of current interest will also be included. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 441 or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 646: *Bioinorganic Chemistry*. 3 credits.

Applies inorganic coordination chemistry and physical methods to understand structure and function of metal ion sites in biomolecules. Biochemical roles of metal centers in oxygen transport, metalloenzymes, and electron transfer. Topics include iron cytochromes, zinc and copper enzymes, cobalamins, iron sulfur proteins, inorganic model compounds, and metals in medicine. Inorganic core course. Offered by

Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 441, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 651: *Environmental Chemistry of Organic Substances*. 3 credits. Study of principles governing multimedia distribution and fate of organic chemicals in environment. Overview of origin and occurrence of major classes of natural and anthropogenic organic chemicals in environment. Environmental core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: One semester of Physical Chemistry, or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 660: *Protein Biochemistry*. 3 credits. Proteins play critical roles in most biological processes. Therefore, to understand these processes, it is necessary to understand proteins. This course will introduce students to proteins, their biosynthesis/biodegradation and their biophysical and biochemical properties. Biochemistry core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 463 or equivalent or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 661: *Antibiotic Chemistry and Resistance*. 3 credits. Introduces the various classes of antibiotics. Focus on the chemistry of antibiotics and how they inhibit bacterial growth and/or cause death and the response of bacteria to these compounds. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 463 or equivalent or permission of instructor

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 662: *Modern Methods of Drug Discovery*. 3 credits. Introduction to the process of drug discovery. Covers modern methods and strategies of target identification, lead identification, and lead optimization. Biochemistry core course. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 463 (or equivalent) or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 665: *Protein-Protein Interactions: Methods and Applications*. 3 credits. Introduction to the fundamental principles of protein-protein interactions, including experimental design considerations and methods for quantification of these interactions. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 463 (or equivalent), or permission of instructor.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 670: Teaching Practicum. 2 credits.

Prelaboratory lecture and laboratory teaching in chemistry. Students work closely with faculty and are responsible for all aspects of teaching undergraduate laboratory techniques. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: Enrollment in the graduate program and permission of Chair.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Enrollment is limited to Graduate, Non-Degree or Undergraduate level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Internship

Grading:

This course is graded on the Graduate Special scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 680: Fundamentals of Nanoscience and Nanomaterials. 3 credits.

This course will i) start with physical chemistry and surface science to elucidate the fundamental concepts and unique properties of solid materials emerging at the nanoscale; ii) introduce both "top-down" and "bottom-up" approaches to the fabrication of nanostructures and nanomaterials; iii) discuss advanced tools for characterizing the physical and chemical properties of nanomaterials; iv) review recent developments of nanomaterials for applications in catalysis, electronics, optoelectronics, energy, and nanomedicine; and v) discuss the environmental, health and safety (EHS) issues of nanomaterials for understanding the societal impact of nanotechnology. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: A grade of C or better in CHEM 331 and 332, MATH 113 and 114

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy, Graduate, Junior Plus, Non-Degree or Senior Plus.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

700 Level Courses**CHEM 728: Introduction to Solid Surfaces. 3 credits.**

Introduces properties of solid surfaces. Topics include gas absorption isotherms, surface area measurement techniques, real and clean surfaces, physisorption and chemisorption, methods of gas adsorption and desorption, measurement of heats of adsorption, desorption kinetics, electron spectroscopies and surface sensitivities, instrumentation; and principles of vacuum technology. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit. Equivalent to CSI 712.

Recommended Prerequisite: CHEM 422 or equivalent.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 735: Astrophysical Chemistry of Planetary Bodies. 3 credits.

In depth review of the chemistry of planets, comets and other bodies in the Solar System. Emphasis will be placed on the laboratory techniques and measurements made in order to understand and predict astronomical observations. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 331, or ASTR 403, or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 736: Computational Quantum Mechanics. 3 credits.

Study of fundamental concepts of quantum mechanics from computational point of view, review of systems with spherically symmetric potentials, electron-atom solutions to Schrodinger's equation, electron spin in many electron systems, atomic structure calculations, algebra of many electron calculations, Hartree-Fock, self-consistent field method, molecular structure calculations, scattering theory computations, and solid-state computations. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit. Equivalent to CSI 783, PHYS 736.

Recommended Prerequisite: PHYS 502, 510, or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 767: *Industrial Biochemistry*. 3 credits.

An introduction to industrial biochemistry. Includes a mechanistic examination of the biosynthesis of several industrially important secondary metabolites, the industrial scale process of obtaining commercially valuable biochemical products, and the regulations that oversee the industrial biochemical process. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 463 or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 790: *Graduate Seminar*. 1 credit.

Selected topics from recent chemical theory and applications, generally consisting of research presentations by invited faculty from other institutions. Attendance is required at 80% of the seminars and students must write up a 1 page summary of each talk attended. Course also used to teach students effective presentation methods. Notes: Requires, in last semester, seminar presentation on student's research or another topic acceptable to department. Three credits of CHEM 790 required for MS degree; an additional 3 credits required after admission to PhD program. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree for a maximum 3 credits.

Recommended Prerequisite: Admission to a graduate program in Chemistry and Biochemistry, or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Seminar

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 796: *Directed Reading and Research*. 1-6 credits.

Reading and research on a specific topic in chemistry or biochemistry under direction of a faculty member. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree for a maximum 12 credits.

Recommended Prerequisite: Admission to a graduate program in Chemistry and Biochemistry or affiliated programs.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Research

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 798: *Research Project*. 3-6 credits.

Experimental or theoretical research project chosen and completed under guidance of graduate faculty member. Notes: Requires comprehensive report acceptable to advisory committee, and final oral exam on report. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree for a maximum 6 credits.

Recommended Corequisite: Permission of department; 6 credits of CHEM 798 or 799 (credit will not be given for both).

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Thesis

Grading:

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 799: *Master's Thesis*. 1-6 credits.

Laboratory thesis research and writing under direction of supervisor. Notes: Minimum of 3 credits for first two enrollment periods. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree.

Recommended Corequisite: Permission of the department.

Registration Restrictions:

Enrollment is limited to Graduate or Non-Degree level students.

Students in a Non-Degree Undergraduate degree may **not** enroll.

Schedule Type: Thesis

Grading:

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

800 Level Courses

CHEM 814: *Advanced Bioorganic Chemistry*. 3 credits.

Introduces the chemical nature of biomolecules, with a focus on their organic properties. Focuses on the chemical principals that underlie the diverse structures, properties and reactions of biomolecules. Core course in the Chemistry and Biochemistry doctoral program. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 313, 314, and 463 or equivalent; or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 817: *Organic Structural Spectroscopy*. 3 credits.

Spectroscopic determination of organic molecular structure using ¹H, ¹³C, ¹⁹F, and ³¹P nuclear magnetic resonance, infrared, ultraviolet, visible, and Raman spectroscopy, and mass spectrometry. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 314 or equivalent.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 821: *Theory of Analytical Processes*. 3 credits.

Theory and application of contemporary analytical processes and methods used in chemistry research. Emphasis on analytical signals and accompanying noise, sample preparation techniques, and quality assurance in measurements. Core course in the Chemistry and Biochemistry doctoral program. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: Admission to Chemistry and Biochemistry doctoral program.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 833: *Physical Chemistry and Biochemistry*. 3 credits.

The theory and practical use of thermodynamics, kinetics, spectroscopy and quantum chemistry in chemical and biochemical research. Core course in the Chemistry and Biochemistry doctoral program. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: CHEM 331 or permission of instructor.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 891: *Doctoral Scientific Critique, Writing and Presentation*. 3 credits.

Development of skills associated with scientific communication and research such as oral presentation of scientific material, analysis of

scientific research and preparation of scientific proposals. In preparing scientific proposals, students will learn how to identify scientific questions of interest and how to plan a course of experiments to address these questions. Core course in the Chemistry and Biochemistry doctoral program. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May not be repeated for credit.

Recommended Prerequisite: Permission of academic advisor, research advisor and/or research committee

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Lecture

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 896: *Doctoral Directed Reading and Research*. 1-6 credits.

Reading and research on a specific topic in Chemistry or Biochemistry under direction of a faculty member. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree for a maximum 15 credits.

Recommended Prerequisite: Admission to the PhD in Chemistry and Biochemistry or affiliated programs.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Research

Grading:

This course is graded on the Graduate Regular scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

900 Level Courses

CHEM 998: *Doctoral Dissertation Proposal*. 1-12 credits.

Development of a research proposal under the guidance of the research advisor and graduate committee. The resulting proposal, once approved by the student's research advisor and committee, forms the basis of the student's doctoral dissertation. May be repeated for credit, but no more than 24 combined credits from CHEM 998 and CHEM 999 may be applied toward satisfying doctoral degree requirements, with no more than 12 credits of CHEM 998. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree.

Recommended Prerequisite: Permission of research advisor and/or graduate committee.

Registration Restrictions:

Enrollment is limited to Graduate level students.

Schedule Type: Dissertation

Grading:

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)

CHEM 999: *Doctoral Dissertation Research*. 1-12 credits.

Research in the concentration pertinent to student's program of study under the direction of their research advisor and committee. Students

may enroll for credits in this course once their research proposal has been approved. May be repeated for credit, but no more than 24 combined credits from CHEM 998 and CHEM 999 may be applied toward satisfying doctoral degree requirements, with no more than 12 credits of CHEM 998. Offered by Chemistry (<http://catalog.gmu.edu/colleges-schools/science/chemistry-biochemistry/>). May be repeated within the degree.

Recommended Prerequisite: Admission to candidacy in Chemistry and Biochemistry Doctoral Program.

Registration Restrictions:

Enrollment limited to students with a class of Advanced to Candidacy.

Enrollment is limited to Graduate level students.

Schedule Type: Dissertation

Grading:

This course is graded on the Satisfactory/No Credit scale. (<http://catalog.gmu.edu/policies/academic/grading/>)